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AUTHOR Shell, Duane F.; And Others
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ABSTRACT

This research was conducted as part of Project CIRCLE, a collaborative project between the University of Texas at Austin College of Education, the Austin Independent School District, and the Eanes Independent School District. The intent of the project was to establish collaborative knowledge-building communities in high school classrooms among secondary students and teachers and university students and faculty supported by innovative constructivist uses of computer technology. The primary goal was to determine the effects of such knowledge-building communities on students' approaches to learning. The study took place in one inner city and one suburban high school in the Austin, Texas area. The Student Perceptions of Classroom Knowledge-Building (SPOCK) instrument measured four aspects of students' perceptions of their own knowledge building and intentional learning behavior: (1) knowledge building; (2) question asking; (3) self-regulation; and (4) lack of initiative. In addition, the instrument measured extent of teacher directedness in the classroom and extent of collaborative learning among students. Overall, the results suggest that the infusion of technologies that support knowledge building, intentional learning, and collaboration can enhance the establishment of collaborative knowledge-building communities in high school classrooms and can influence students' perceptions of the classroom environment. (AEF)

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Effects Of Collaborative, Computer-Supported, Knowledge-Building Communities On High School Students' Knowledge Building And Intentional Learning

Duane F. Shell, Jeannine E. Turner, Jenefer Husman,
Deborah M. Droesch-Cliffel, Indira Nath, Noelle Sweany

Department of Educational Psychology
The University of Texas at Austin

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Effects Of Collaborative, Computer-Supported, Knowledge-Building Communities On High School Students' Knowledge Building And Intentional Learning

Background and Theoretical Perspectives

This research was conducted as part of Project CIRCLE: a collaborative project between the University of Texas at Austin College of Education, the Austin Independent School District (AISD) and the Eanes Independent School District (EISD). The intent of the project was to establish collaborative knowledge-building communities in high school classrooms among secondary students and teachers and university students and faculty supported by innovative constructivist uses of computer technology. The primary goal of this research project was to determine the effects of the implementation of these knowledge building communities on students' approaches to learning, engagement in intentional learning, and perceptions of the classroom. The Project CIRCLE utilized a learning model based on the knowledge building and constructivist approach of Bereiter, Scardamalia, and their colleagues at the Ontario Institute for Studies in Education (Bereiter & Scardamalia, 1989; Scardamalia & Bereiter, 1991; Scardamalia & Bereiter, 1992; Scardamalia, Bereiter, & Lamon, 1994; Scardamalia, Bereiter, McLean, Swallow, & Woodruff, 1989). Central to this learning model is the idea that meaningful learning involves the production of knowledge rather than the reproduction of knowledge. This knowledge building is accomplished by an in-depth study of a topic that goes beyond simple factual or recall learning. It requires the construction of new knowledge, connection of new information to existing knowledge, and the integration of knowledge across topics and domains. Knowledge building is supported by intentional learning. Intentional learning is characterized by an active self-regulated approach to learning and by beliefs that knowledge is an evolving entity. Students who are intentional learners approach their learning with goals of exploring and expanding their knowledge and view learning as problem solving. They are also planful in their approach to learning and utilize appropriate learning strategies. Furthermore, they recognize knowledge gaps and ask questions that are directed toward filling in these gaps.

Theoretically, knowledge building and intentional learning are thought to be facilitated by what has been termed computer support for collaborative learning (CSCL) (see Koschmann, 1993/94a). The premises of CSCL are drawn from the use of computers for the facilitation of collaborative work environments (termed computer support for collaborative work or CSCW). The computer in these environments is used to facilitate, augment, and/or redefine the interactions among members of a work group (Koschmann, 1993/94b). When translated into an instructional, learning context, the computer is used in CSCL to facilitate and redefine the interactions among students with each other, and students and teachers. Project CIRCLE had as a goal the use of CSCL to facilitate the restructuring of classroom practices toward (a) greater collaboration among students, (b) alteration of the teacher's role from transmitter of information to facilitator of knowledge building, and (c) enhanced student directed intentional learning and knowledge building. For these purposes, Project

CIRCLE utilized a number of technologies and specific collaborative computer tools including interactive brainstorming and writing tools (the Daedalus program), telecommunication links between classrooms within and between schools, and internet/world wide web access.

Our examination of student knowledge building and intentional learning focused on three areas: (a) student approaches to knowledge building, examined by assessing students goals for their knowledge acquisition and the extent to which they engaged in behaviors that expand and extend knowledge as opposed to behaviors that foster memorization of given knowledge; (b) student engagement in intentional learning, examined by assessing the extent to which students used cognitive and metacognitive strategies to facilitate their learning and to exercise self-regulation of their learning; and (c) students perceptions of the classroom as a computer support for collaborative learning (CSCL) environment, examined by assessing students' perceptions of cooperation and collaboration in the classroom and their perceptions of the extent to which the classroom was teacher directed versus self-directed.

Method

Participants. The study took place in two high schools in the Austin, Texas area. School A was an innercity, urban school with a predominantly minority population. School B was a suburban school with a predominantly White, middle and upper middle class population. In both years, student participants were in classes of varying subject matter taught by the teachers participating in Project CIRCLE. In year 1, there were 446 students (259 from school A; 187 from school B) in the fall semester sample and 317 students (180 from school A; 137 from school B) in the spring semester sample. These students were from the classrooms of 8 teachers (6 from school A; 2 from school B). In year 2, there were 946 students (310 from school A; 636 from school B) in the sample. These students were from the classrooms of 18 teachers (10 from school A; 8 from school B). There were an approximately equal number of boys and girls in all samples.

Measures. Student knowledge building, intentional learning, and perceptions of the CSCL classroom were measured using the Student Perceptions of Classroom Knowledge-Building (SPOCK) instrument developed by the authors as part of Project CIRCLE (see Shell, Husman, Droesch, Nath, Wall, & Turner, 1995 for full data on instrument development and metric properties). The instrument measures four aspects of students' perceptions of their own knowledge building and intentional learning behavior: (a) knowledge building (e.g., Whenever I learn something new in this class, I try to tie it to other facts and ideas that I already know. In this class, I ask questions that can only be answered by exploring new information. As I study the topics in this class, I try to think about how they relate to the topics I am studying in other classes.); (b) question asking (e.g., In this class, I ask question to help me better understand the things I am trying to learn. In this class, I ask questions to be clear about what the teacher wants me to learn.); (c) self-regulation (e.g., In this class, I try to determine the best approach for studying each assignment. In this class, I try to monitor my progress when I study. In this class, I make plans for how I will study.), and (d) lack of initiative (e.g., In this class, when I get stuck or confused about my schoolwork, I need someone else to figure out what I need to do. In this class, I have troubie figuring out how to approach studying.). The instrument also measures two aspects of students perceptions of the classroom environment: (a) extent of teacher directedness of the classroom (e.g., In this class, I get most of the information from the textbook and the teacher. In this class, the teacher gives us specific instructions on what we are to do.), and (b) extent of collaborative learning among students (e.g., In this class, my classmates and I actively work together to help each other understand the material. In this class, my classmates and I actively share ideas.). In year 2 additional items were added to the question asking scale, allowing separation of subscores representing high level questions (e.g., In this class, I ask questions in order to help me learn new things. In this class, I ask questions about things I am curious about.) and low level questions (e.g., In this class, I ask questions so that I can be sure I know the right answers for tests.).

Procedures. In year 1, the SPOCK was administered during the fall semester to collect baseline data and at the end of the spring semester to collect data following implementation of the CIRCLE software. In year 2, the SPOCK was administered at the end of the spring semester. Students completed all instruments in their classrooms. In the first year, administration was done by high school students who were working as student mentors as part of the CIRCLE project with neither the classroom teachers nor the researchers present while the instruments were administered. In the second year, administration was done by members of the research team with classroom teachers either present or not at their choice.

Data Analysis

To determine the effects of the implementation of the CIRCLE learning model on students' perceptions of knowledge building, intentional learning, and the classroom environment, we compared the perceptions of students in classrooms where the learning model was more fully implemented to the perceptions of students in classroom where the learning model was not as fully implemented. Teacher integration of the CIRCLE learning model and extent of technology use was determined from interviews conducted with the teachers at the end of each of the two school years as part of the Project CIRCLE evaluation (see Shell et al., 1995). Technology use (high versus low) was determined based on teachers' reports of how extensively they used the technology in their classrooms during the spring semester, in year 1, and during the year, in year 2. Integration of the CIRCLE learning model (high versus low) was determined based on teachers' reports of whether they had altered their own teaching toward a more knowledge building, collaborative approach as a result of using the CIRCLE technology, and their reports that use of the technology had produced changes in student learning and collaboration that continued on subsequent assignments even when the technology was not being used.

In year 1, technology use and integration of the CIRCLE learning model were virtually identical. Four teachers (high integration) reported using the technology, and, although this use was low in all cases, all four also reported changes in teaching and changes in student learning and collaboration. The remaining four teachers (low integration) did not use any of the technology and did not report any changes in teaching. We conducted comparisons between these two groups in their students' scores on the six knowledge building and intentional learning scales using *t* tests with an alpha level of $p < .05$ both in the fall semester, prior to any use of the technology or implementation of the CIRCLE learning model, to get a baseline on whether the teachers differed before implementation of the project, and in the spring semester to compare whether implementation produced in changes in students' perceptions. True repeated measures analysis was not possible because students were not always the same in both semester, therefore, we analyzed each semester separately.

In year 2, there was a difference between use and integration. In relation to use, 3 teachers (high use) reported high levels of technology use, 12 teachers (medium use) reported moderate use, and 3 teachers (low use) reported either no or very minimal use. These use patterns did not directly reflect integration of the learning model, however. The three teachers reporting high use also reported changes in teaching and changes in student learning and collaboration, and the three teachers reporting low use also reported no changes in teaching or student learning. Among the 12 teachers with moderate, and approximately equal levels of use, however, 5 reported changes in teaching and changes in student learning and collaboration and 7 reported no changes. Therefore, the high integration group was composed of the 3 high use teachers and the 5 medium use teachers reporting high integration (8 total), and the low integration group was composed of the 3 low use teachers and the 7 medium use teachers reporting low integration (10 total). We conducted comparisons between the high and low integration groups in their students' scores on the six knowledge building and intentional learning scales using *t* tests with an alpha level of $p < .05$. To examine whether use of technology had an effect separate from integration of the learning model, we compared conducted comparisons between the teachers within the high integration group and comparisons between the teachers within the low integration group based on differences in use. Within the high integration group, there were 3 high use teachers and 5 medium use teachers whose students were compared. Within the low integration group, there were 7 medium use teachers and 3 low or no use teachers whose students were compared. These comparisons were done using *t* tests with an alpha level of $p < .05$.

Results

We could not examine whether there was any interaction between high and low integration and the two schools because their were no low integration teachers in School B. We, therefore, did all analyses using the entire sample from both schools combined. The means, standard deviations, *t* test results, and effect sizes for year 1 for both the fall and spring semester assessments are reported in Table 1. For the baseline, fall semester data, the only significant difference occurred for knowledge building, where the students in classes taught by the high integration group reported significantly lower knowledge building. At the end of the spring semester, this pattern of differences had changed.

The high and low integration groups were no longer significantly different in their students' knowledge building scores, suggesting that integration of the CIRCLE learning model and use of CIRCLE technology did have an effect of increasing knowledge building such that in classes where knowledge building scores were initially significantly lower, these scores were increased to a point where there were now no differences. Also, students in classes taught by the high integration group reported significantly higher perceptions of collaboration with peers and more question asking whereas, in the fall, there had been no differences in the scores on these measures. The effect size for question asking was almost one-third of a standard deviation, and the effect size for collaborative learning was over one-third of a standard deviation. These suggest meaningful differences between the groups that have practical as well as statistical significance.

Because there were high and low integration teachers in both schools, we initially conducted a 2 (high vs low integration) x 2 (School A vs School B) MANOVA to examine whether there was any differential effect of integration in the two schools. This MANOVA indicated no interaction between school and integration; therefore, we conducted the analysis of integration using the entire sample from both schools combined. The means, standard deviations, *t* test results, and effect sizes for year 2 for the comparisons between the high and low integration groups are reported in Table 2. Students in classes taught by the high integration group reported significantly higher knowledge building, question asking, both low and high level, self-regulation, and perceptions of collaboration with peers. The effect sizes for knowledge building and self-regulation were somewhat small, less than one-fifth of a standard deviation, but were possibly large enough, over .15, to be meaningful. The effect sizes for question asking and both question asking subscales approached one-fourth of a standard deviation, suggesting a meaningful difference. The effect size for collaborative learning was above one-third of a standard deviation, suggesting a fairly strong effect.

The means, standard deviations, *t* test results, and effect sizes for year 2 for the comparisons based on use differences are reported in Table 3 for the high integration group and Table 4 for the low integration group. Within the high integration group, students taught by teachers who used the technology more reported significantly higher high level question asking and perceptions of collaboration with peers and significantly lower perceptions of teacher directedness. The effect sizes for all these differences all appeared meaningful, ranging from about one-fourth of a standard deviation for teacher directedness to approximately two-fifths of a standard deviation for high level question asking. Within the low integration group, students taught by teachers who used the technology more reported significantly higher knowledge building, with an effect size of almost one-third of a standard deviation. The differences identified were not as pervasive as those found for integration of the learning model, but in terms of effect size, the differences were at least as large as those found for integration. The results, therefore, do suggest an additional effect for technology use above and beyond that attributable to integration of knowledge building teaching practices.

The results indicated differences between students on the SPOCK scales as a result of teacher integration of the CIRCLE learning model and use of technology. These differences are to some extent important only if higher knowledge building and intentional learning, and greater collaboration in the classroom are, in fact, associated with greater learning and achievement. To examine whether scores on the SPOCK were related to students' achievement, we conducted multiple regression analyses using the year 2 data, regressing students' course grades in the classes surveyed on the SPOCK scores. Because many of the SPOCK scales were highly intercorrelated, the weighting of the variables in the regression equation could be somewhat arbitrary, because only one of a set of highly intercorrelated predictors will receive a high weighting (Beta). Therefore, we also computed structure coefficients or loadings by correlating students' predicted scores computed from the regression equation with their scores on each of the original variables. These loadings are similar to factor loadings or canonical correlation structure coefficients and indicate which sets of variables are associated with the dimension defined by the linear combination of the variables created by the regression equation. We conducted regression analyses for the total sample and, because the grade means were considerably different in the two schools (see Table 5), for each school separately.

The regression results and structure coefficients are provided in Table 5. Significant prediction of grades was achieved in the total sample and both schools. However, the magnitudes of the explained variance were small for the total sample and School B. Examination of the mean and standard deviation for School B suggests that predictability was lowered because of a general lack of variability in School B grades due to a rather strong ceiling effect. This undoubtedly affected the variability in the total sample as well given that almost two-thirds of the sample were School B students. In School A where there was no ceiling effect and more variability in grades, SPOCK scores predicted 15% of the grade variance. Although in absolute magnitude this is still somewhat low, when considered in relation to the predictability of actual course grades commonly achieved in educational research, the 15% explained variance seems quite respectable. As we expected due to the high intercorrelations of the SPOCK scales, there were few variables that were significant in the final regression equations, with lack of initiative the only variable that was significant in the total sample and both schools. The loadings provide a more complete picture of the associations between SPOCK scores and grades. In all analyses, the loadings suggested that the cluster of question asking, self-regulation, and perceptions of collaborative learning was positively associated with higher achievement, with knowledge building also being a part of this cluster in the total sample and School A. Lack of initiative was negatively associated with higher achievement. In the total sample and School B, perceptions of teacher directedness grouped with lack of initiative, however, teacher directedness was positively associated in School A. Except for the inconsistent results for teacher directedness, these loadings are those that would be expected based on the premises of the CIRCLE learning model.

Discussion

The results of all analyses point to a consistent effect of implementation and use of the CIRCLE learning model and the associated CSCL technologies on students' knowledge building, intentional learning, and perceptions of the classroom environment. In relation to our three central areas of examination, higher integration of the CIRCLE constructivist and knowledge-building oriented learning model appeared to positively affect students' engagement in knowledge building in the classroom. There were strong effects on question asking in both years and evidence of positive effects on knowledge building activities in both years. These effects suggest that the implementation of knowledge-building oriented instruction does influence students' approaches to learning by increasing their more knowledge building oriented activities and goals. The effect of higher integration of the CIRCLE learning model on students' intentional learning was less. There were no effects on lack of initiative in either year and only a small effect on self-regulation activities in the second year. When separated from the more explicit knowledge-building activities and goals assessed in the knowledge building and question asking scales, our intentional learning measures reflect more traditional self-regulation as has been proposed in a number of models (e.g., Zimmerman, 1989). The types of metacognitive and cognitive strategies assessed can be done in both traditional and more constructivist, knowledge-building oriented classrooms. What is suggested by our results is that these types of intentional learning or self-regulation are not necessarily affected much by the type of classroom environment present. In effect, because they are not uniquely associated with a knowledge building approach to learning, they are not influenced much if at all by implementation of a knowledge building environment in the classroom.

CSCL approaches (Koschmann, 1993/94a, 1993/94b; Scardamalia & Bereiter, 1991; Scardamalia et al., 1994) propose that computer supports provide special facilitation to the implementation of constructivist, knowledge-building environments. The results of the examination of differential use within the high and low integration groups suggest that computer supports do perhaps provide this facilitation. Among high integration teachers, those using the computer supports more had students who reported more higher level question asking, with moderate, although nonsignificant, effect sizes also found for knowledge building and overall question asking. Among low integration teachers, those using the computer supports more had students who reported more knowledge building. The effects for computer use examined separately from integration of the learning model are considerably smaller than those for integration of the constructivist, knowledge building learning model, but are large enough to suggest a unique effect for computer supports. In essence, our findings would tentatively support the contention of CSCL that computer technology facilitates more constructivist, knowledge-building oriented learning.

A central aspect of the classroom environment envisioned in the CIRCLE learning model as well as other CSCL approaches is increased student collaboration. The results from both years indicate that implementation of the CIRCLE learning model lead to strong increases in students' perceptions of collaboration with their fellow students in their classes. When considering computer use within the two integration groups, similar results were obtained, with perceptions of collaboration being higher when computers were used more, although being significantly higher only within the high integration group. These findings are particularly interesting in year 2 because those teachers who did not implement the model as fully reported in their interviews that they were already doing extensive collaboration in their classrooms because in both schools, collaborative teaching approaches had been mandated by the respective school administrations. That integration of the CIRCLE learning model and higher use of CSCL produced large increases in perceptions of collaboration in schools where collaborative learning was supposed to be the norm suggests a unique effect on collaboration in CSCL supported constructivist, knowledge building environments. We speculate that this effect occurred because collaboration is more central to the activities done on the CSCL technology used in the CIRCLE learning model. Basically, the types of technology used in the CIRCLE project necessitate real peer collaboration for completion of the classroom projects and activities. This may be perceived by students as more authentically collaborative than more traditional assignments that are done collaboratively in cooperative groups. The results do strongly suggest that CSCL technologies when coupled with a more constructivist, knowledge-building approach do enhance student collaboration.

Within the CSCL field, increased collaboration is often contrasted with a more traditional teacher centered approach. Our findings are less clear on student perceptions of teacher directedness than on increased collaboration, however. Perceptions of teacher directedness were not affected by high versus low integration of the CIRCLE learning model and only were significantly different for computer use within the high integration group. However, unexpectedly, students in the classes of high use, high integration teachers perceived more teacher directedness. This one significant finding may be an anomaly of the rather small number of students in the high use, high integration classrooms, given that there were no differences in other comparisons. The results do, however, suggest that collaboration and teacher directedness are independent of each other rather than being opposites on the same continuum. They also suggest that increasing students knowledge-building and collaboration does not necessarily require diminishing the role of the teacher.

Although not a central question in this study, the results on the relations of knowledge-building and intentional learning measures and student grades are encouraging. Although the effects were small, they were obtained on traditional measures of classroom achievement. All teachers were operating under the normal grading practices in their schools. There were no special grading policies or customized assessments done. Increasing students' constructive, knowledge-building learning orientation and increasing collaborative activities are sometimes questioned because it is thought that they will reduce performance on more traditional assessments. Our findings suggest this is not the case. A knowledge-building approach to learning appears to facilitate higher achievement even on traditional measures. The results for School A, the innercity, predominantly minority urban school, are particularly impressive. Constructivist, knowledge-building approaches to instruction are often ignored in historically poor achieving schools in favor of a more basics oriented approach. Our results, however, suggest that implementation of CSCL knowledge-building approaches can potentially produce greater facilitation of achievement on traditional assessments in these schools than in traditionally high achieving White suburban schools. We do point out that in all assessments, lack of initiative, which reflects lack of knowledge of intentional learning strategies and inability to self-initiate and self-regulate ones own learning, was the strongest predictor in a negative manner, of grades. Lack of initiative was not influenced by implementation of the CIRCLE learning model or the CSCL technology. This would suggest that intervention to improve general self-regulatory and intentional learning skills is perhaps needed before students who lack these skills can fully engage in and benefit from a CSCL knowledge-building environment.

Overall, our results suggest that the infusion of technologies that support knowledge building, intentional learning, and collaboration can enhance the establishment of collaborative knowledge-building communities in high school classrooms and can influence students' engagement in knowledge building and intentional learning and students' perceptions of the classroom environment. We would caution, as also noted by Scardamalia et al. (1994), that CSCL technology is only a support. A collaborative knowledge-building environment can be created without technology. Our findings do suggest, however, that CSCL technology appears to facilitate the creation of this type of environment in the classroom.

References

Bereiter, C., & Scardamalia, M. (1989). International learning as a goal of instruction. In L. B. Resnick (Ed.), Knowing, learning, and instruction: Essays in honor of Robert Glaser (pp. 361-392). Hillsdale, NJ: Erlbaum.

Koschmann, T. D. (Ed.). (1993/94a). Computer support for collaborative learning [Special issue]. The Journal of the Learning Sciences, 3(3).

Koschmann, T. D. (Ed.). (1993/94b). Toward a theory of computer support for collaborative learning. The Journal of the Learning Sciences, 3, 219-225.

Scardamalia, M., & Bereiter, C. (1991). Higher levels of agency for children in knowledge building: A challenge for the design of new knowledge media. The Journal of the Learning Sciences, 1, 37-68.

Scardamalia, M., & Bereiter, C. (1992). Text-based and knowledge-based questioning by children. Cognition and Instruction, 9, 177-199.

Scardamalia, M., Bereiter, C., & Lamon, M. (1994). CSILE: Trying to bring students into world 3. In K. McGilley (Ed.), Classroom lessons: Integrating cognitive theory and classroom practice (pp. 201-228). Cambridge, MA: MIT Press.

Scardamalia, M., Bereiter, C., McLean, R. S., Swallow, J., & Woodruff, E. (1989). Computer-supported intentional learning environments. Journal of Educational Computing Research, 5, 51-68.

Shell, D. F., Husman, J. E., Droesch, D. M., Nath, I., Wall, N., & Turner, J. (1995). Project CIRCLE first year evaluation report. University of Texas, College of Education, Learning Technology Center.

Zimmerman, B. J. (1989). A social cognitive view of self-regulated academic learning. Journal of Educational Psychology, 81, 329-339.

Table 1

Year 1

Mean Scores on Students' Knowledge Building, Intentional Learning, and Perceptions of the Classroom Environment by Teacher Integration of the CIRCLE Learning Model and Technology

	Fall		Spring			
	Integration		Integration			
	High[a]	Low[b]	High[c]	Low[d]	t	ES
Knowledge building						
M	2.60	2.74	3.01	3.02	-.09	-.01
SD	.68	.65	.72	.78		
Question asking						
M	2.72	2.76	3.46	3.21	2.75**	.31
SD	.75	.75	.80	.78		
Self-regulation						
M	2.60	2.59	2.93	3.00	-.69	-.09
SD	.76	.74	.78	.83		
Lack of initiative						
M	2.67	2.64	2.61	2.67	-.78	-.08
SD	.83	.81	.71	.81		
Teacher directedness						
M	2.98	2.95	3.66	3.79	-.53	-.19
SD	.56	.58	.68	.73		
Collaborative learning						
M	2.78	2.90	3.65	3.33	3.37**	.39
SD	.74	.76	.82	.81		

Note. ES = effect size computed by Cohen's d. t values and effect sizes are for comparisons between the high and low integration groups for the spring semester. df = 315 for all t tests. For the fall semester, means for knowledge building differ significantly at $p = .04$, $t(436) = 2.11$.

[a]n = 223. [b]n = 123. [c]n = 199. [d]n = 118.

**$p < .01$.

Table 2

Year 2

Mean Scores on Students' Knowledge Building, Intentional Learning, and Perceptions of the Classroom Environment by Teacher Integration of the CIRCLE Learning Model

	High Integration (n = 401)		Low Integration (n = 545)			
	M	SD	M	SD	t	ES
Knowledge building	2.89	.82	2.74	.81	2.77**	.18
Question asking						
Overall	3.38	.82	3.18	.86	3.58***	.24
Low level	3.34	.88	3.15	.93	3.14**	.21
High level	3.44	.91	3.22	.93	3.51***	.24
Self-regulation	2.83	.75	2.71	.77	2.35*	.16
Lack of initiative	2.80	.66	2.88	.61	-1.88	-.13
Teacher directedness	3.59	.74	3.63	.71	-.79	-.06
Collaborative learning	3.55	.80	3.24	.86	5.58***	.36

Note. ES = effect size computed by Cohen's d. df = 944 for all t tests.

*$p < .05$. **$p < .01$. ***$p < .001$.

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Table 3

Year 2

Mean Scores on Students Knowledge Building, Intentional Learning, and Perceptions of the Classroom Environment by Differential Use of Technology Within the High Integration Group

	High Use (n = 88)		Medium Use (n = 313)			
	M	SD	M	SD	t	ES
Knowledge building	3.04	.89	2.85	.80	1.82	.23
Question asking						
Overall	3.52	.78	3.34	.83	1.85	.22
Low level	3.36	.84	3.34	.90	.27	.02
High level	3.73	.90	3.36	.90	3.42**	.41
Self-regulation	2.94	.73	2.80	.76	1.65	.19
Lack of initiative	2.75	.62	2.81	.67	-.76	-.09
Teacher directedness	3.74	.66	3.55	.76	2.36*	-.24
Collaborative learning	3.73	.80	3.50	.80	2.34*	.31

Note. ES = effect size computed by Cohen's d. df = 129.39 for knowledge building; df = 147.13 for overall question asking; df = 147.14 for low level question asking; df = 139.52 for high level question asking; df = 144.23 for self-regulation; df = 148.45 for lack of initiative; df = 157.72 for teacher directedness; df = 139.27 for collaborative learning.
*p < .05. **p < .01.

Table 4

Year 2

Mean Scores on Students Knowledge Building, Intentional Learning, and Perceptions of the Classroom Environment by Differential Use of Technology Within the Low Integration Group

	Medium Use (n = 468)		Low or No Use (n = 77)			
	M	SD	M	SD	t	ES
Knowledge building	2.78	.82	2.53	.74	2.68**	.31
Question asking						
Overall	3.20	.87	3.09	.81	1.04	.13
Low level	3.18	.94	3.01	.89	1.55	.18
High level	3.23	.94	3.21	.86	.13	.02
Self-regulation	2.69	.79	2.82	.64	-1.61	-.17
Lack of initiative	2.88	.60	2.84	.68	.54	.07
Teacher directedness	3.62	.69	3.63	.78	-.04	-.01
Collaborative learning	3.27	.84	3.05	1.00	1.81	.26

Note. ES = effect size computed by Cohen's d. df = 109.61 for knowledge building; df = 107.24 for overall question asking; df = 105.41 for low level question asking; df = 108.14 for high level question asking; df = 118.02 for self-regulation; df = 96.54 for lack of initiative; df = 96.69 for teacher directedness; df = 94.13 for collaborative learning.
**p < .01.

Table 5

Full Model Regression Analysis of Course Grades on SPOCK Scores

Variable	B	SE B	Beta	Loading
		Total Sample (N = 677; M = 86.03; SD = 9.97; R = .26; R^2 = .07)		
Knowledge building	.25	.66	.02	.37
Question asking				
Low level	1.77	.63	.17**	.56
High level	.07	.65	.01	.50
Self-regulation	-.89	.70	-.07	.15
Lack of initiative	-2.72	.60	-.18**	-.76
Teacher directedness	-.77	.58	-.06	-.19
Collaborative learning	.50	.51	.04	.40
		School A (N = 236; M = 81.31; SD = 12.11; R = .38; R^2 = .15)		
Knowledge building	.41	1.33	.03	.33
Question asking				
Low level	1.62	1.31	.13	.55
High level	1.54	1.26	.12	.58
Self-regulation	-.89	1.51	-.06	.29
Lack of initiative	-5.12	1.08	-.30***	-.73
Teacher directedness	1.76	1.12	.11	.30
Collaborative learning	-.31	.97	-.02	.24
		School B (N = 441; M = 88.56; SD = 7.48; R = .23; R^2 = .05)		
Knowledge building	-.97	.64	-.11	.00
Question asking				
Low level	1.09	.58	.13	.35
High level	.02	.63	.00	.27
Self-regulation	.15	.65	.02	.07
Lack of initiative	-1.64	.62	-.13**	-.72
Teacher directedness	-1.25	.57	-.12*	-.49
Collaborative learning	.62	.50	.07	.34

*p < .05. **p < .01. ***p < .001.